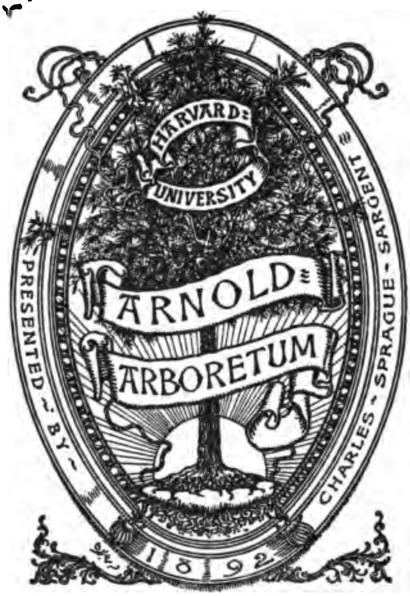
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RELATION OF LIGHT CHIPPING TO THE COMMERCIAL YIELD OF NAVAL STORES.

BY

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ILLUSTRATIONS.

PLATES.

TEXT FIGURES.

RELATION OF LIGHT CHIPPING TO THE COMMERCIAL YIELD OF NAVAL STORES.

PREVIOUS EXPERIMENTS IN TURPENTINING.

In 1902 the Forest Service conducted experiments at Ocilla, Ga., to determine whether a more efficient method of turpentine gathering could not be substituted for the box system, then practically the only one used in the pineries of the South. The results of these experiments, published in Bulletin 40 of the Forest Service, showed that the cup system of turpentining gave an increased yield of resin and a greater profit to the operator, with less damage to the tree. Upon announcement of this discovery the commercial introduction of the system began. The experiments, however, were continued two years longer, in order to obtain a still more accurate comparison of the two systems. At the end of that time a summary of the complete results was published in Circular 34 of the Forest Service. The advantages of the new system were so obvious that it was thought unnecessary to continue this line of experimentation further, especially as the experience of turpentine operators in the commercial application of the system fully confirmed, and in many cases exceeded, the results obtained on the experimental tract.

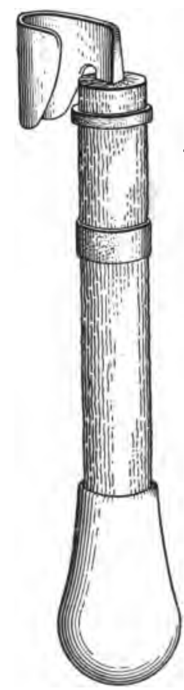

FIG. 1.—Hack with handle and weight.

NEED OF CHIPPING EXPERIMENTS.

The next important feature of turpentining which naturally suggested itself as a basis for comparative experiments was the "chipping," or scarification of the trees. During the winter season on a turpentine farm all hands are engaged either in placing the cups on the trees or in cutting the boxes in preparation for the next season's flow of gum. As a result of the wound made in either process, a certain amount of crude turpentine is collected during the winter, but the flow of this oleo-resin does not continue very long. With the advent of early spring it is again necessary to wound the tree in order to start the flow. This process is called "chipping."

Chipping is done by means of an implement known as a "hack" (fig. 1). This tool consists of a blade of high-grade steel, about 3 inches wide, bent into a U shape. One edge of the blade is sharpened on both arms of the U so that it will cut with either a right or left handed swing. Extending from one end of the cutting blade is a heavy shank, turned at right angles and set into a round wooden handle, about 2 inches in diameter, which varies in length from 12 to 24 inches. The blade is firmly held in this handle by stout iron bands. On the opposite end of the handle is placed a heavy iron weight (fig. 1) which gives momentum to the stroke.

In chipping, the hack is swung with a free arm movement, and drawn downward across the face of the tree toward the workman's body. Then, reversing the position of the hands, another cut is made in the opposite direction. Sometimes but one swing of the hack is needed to make each half of the wound, but usually two or three strokes are necessary. The result is a V-shaped scar or wound, about 14 inches long, three-fourths of an inch wide, and from three-fourths of an inch to 1½ inches deep.

Soon after the wound is made the limpid drops of crude turpentine begin to exude from the resin ducts; most freely in the extreme outer layers of the sapwood, and to a markedly less degree as the cut penetrates deeper into the wood. The gum flows slowly into the receptacle below, where crystallization soon begins, the mass gradually assuming the appearance of fairly well-frozen sherbet.

The rate of exudation of the gum from an average long-leaf pine is given in Table 1, compiled from daily weighings during a period of one week.

TABLE 1.—*Exudation of gum.*

Day.	Grams of gum.	Per cent of total exudation.	Day.	Grams of gum.	Per cent of total exudation.
First	113.0	67.26	Fifth and sixth	9.0	5.36
Second	22.5	13.39	Seventh	1.0	.59
Third	13.5	8.04			
Fourth	9.0	5.36	Total	[2] 168.0	100.00
Fifth (Sunday)	(1)				

[1] No weighing. [2] 168 grams equals 0.37 pound.

This table shows that the greater flow takes place within the first 24 hours, and that after one week it practically ceases. This cessation is probably due to the oxidation and crystallization of the crude turpentine at the mouths of the resin ducts, so that they gradually become clogged. To obtain a further yield from the tree it is necessary to renew the wound, and thus reopen the resin ducts; hence the tree is again chipped. This weekly chipping is continued throughout

the spring, summer, and fall until the yield has decreased to a point where further chipping does not pay. The average chipping season is 32 weeks. One laborer will chip from eight to ten thousand boxes or cups per week. The variation of the flow of crude turpentine at consecutive periods in one season is shown in Table 2 based upon the yield from 5,000 boxes or cups.

TABLE 2.—*Variation of flow of crude turpentine.*[1]

Date of dipping.	Number of chippings.	Barrels of crude turpentine obtained.	Date of dipping.	Number of chippings.	Barrels of crude turpentine obtained.
April 14	3	7⅜	August 18	3	11¾
May 5	3	10⅞	September 8	3	10¼
May 26	3	14½	September 29	3	9½
June 16	3	17⅛	November 4	5	12¾
July 7	3	14¾			
July 28	3	12¾	Total	32	121⅝

[1] This table is taken from Bulletin 40, Forest Service, p. 23.

As the chipped surface is gradually extended up the tree a point is reached, usually at the beginning or middle of the third year of operation, where the use of the hack is no longer practicable. From this point on, the "puller" is substituted. This serves the same purpose as the hack, but its long handle enables the workman to reach higher.

After four years of chipping, a scarified surface, approximately 14 inches wide and 8 feet high, is produced. The work is usually then discontinued.

Great differences of opinion exist among turpentine operators in regard to the depth, width, and height of the wound which should be made in chipping. These varying views are the results of individual observations in the regular course of everyday operations, covering more or less extended periods of time. No records could be found of strictly comparative tests to determine the correctness of any of these views. Yet the great divergence in opinions is proof that some are erroneous, and it seemed important that the matter should be set right.

Moreover, since the experiments described in Bulletin 40 had proved that the "box" is an unnecessary wound which decreases the vitality of the tree, and results in a diminished output from the wound given in chipping, the theory naturally suggested itself that by decreasing the extent of the chipped surface the vitality of the tree might be still further conserved. It appeared reasonable to suppose that a still larger flow of crude turpentine might thus be produced; or at least an equal yield might be obtained from a smaller surface, thus prolonging the period of production.

In short, the fundamental problem of turpentining was held to be, How can a given flow of resin be secured with least injury to the trees? The old method of boxing and chipping inflicted so severe and extensive wounds upon the trees (Pl. II, figs. 1 and 2) that their productiveness was sure to decline rapidly, and the term of operating on a given body of timber was limited to three or four years. In addition to the decline in productiveness among the living trees there was also a progressive loss of trees through death and windfall. Both the prolongation of the turpentine industry and the conservation of the timber supplies of the South called for continuing the search for less destructive methods.

Timberland owners and lumbermen in the turpentine belt have an important interest in the matter because of the considerable loss of lumber each year in the butt cut of turpentined timber. So serious is the decrease in the lumber yield that many owners refuse to allow their timber to be turpentined, feeling that the loss at the mill is greater than the gain from turpentining.

CHIPPING METHOD USED IN FRANCE.

Before beginning experimental work in the woods on the subject of chipping, it was thought best first to make a study of the records and system practiced in France, where for the past 40 years the industry has been conducted on lines insuring its permanency. It was found that the practice in all of the French forests was to chip a face only 4 inches wide and approximately one-half inch deep, while the rate at which the chipped surface was carried up the tree was more rapid than in this country. During the earlier years, under the French system, the tool used in chipping is drawn across the tree in one direction only. In the later years of operation the direction of the stroke gradually becomes perpendicular. The result is the formation of a shallow groove in the tree, which after several years completely heals over.

The former practice of chipping the trees to heights of 20 and 25 feet, by the aid of ladders, has been practically abandoned, four years being now considered the normal period for chipping one face of the tree.

The small yield from such narrow chipped surfaces makes the introduction of the French system into this country impracticable, on account of the high cost of labor, but a comparison of the total yield from four years of operation under the French system with that of a similar period in the forests of this country shows that the decrease in yield is not in proportion to the decrease of the chipping surface. However, it was impossible to find in France authentic records of comparative studies of the yields from chippings of varying width, depth,

FIG. 1.—COMBINED EFFECT OF BOXING AND DEEP CHIPPING. TREE SEVERELY WOUNDED.

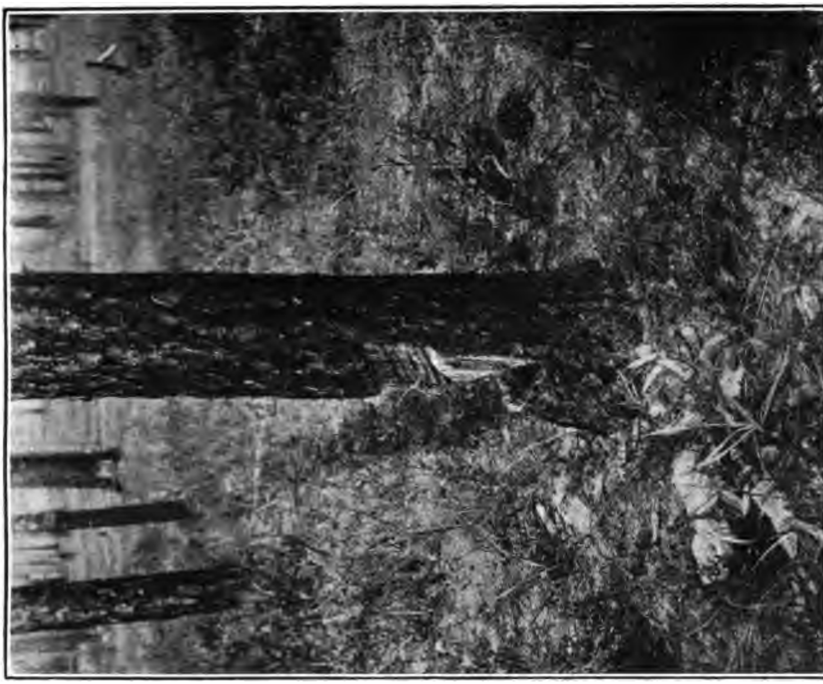

FIG. 2.—SIDE VIEW OF "BOX" CUT IN BASE OF TREE FOR COLLECTING CRUDE TURPENTINE, SHOWING DEPTH OF WOUND.

and height. Nothing remained, therefore, but to get such figures from a series of field experiments.

LOCATING THE EXPERIMENTS.

In locating the experiments four requirements were given principal weight:

First. It was desirable that the results obtained should appeal to as large a number as possible of operators whose operations were carried on under similar conditions of timber and climate. For this reason, Florida was selected as the State best suited for the purpose, since approximately one-half of the naval-stores output of this country comes from Florida.

Second. It was desirable that the experimental tract should be easily reached by railroad, in order that it might be available for inspection by commercial operators. For this reason, a tract in the vicinity of Jacksonville was chosen.

Third. It was important that the stand of timber should consist of a mixed growth of long-leaf pine ("hill pine") and Cuban pine ("slash pine"), the two most important turpentine pines. Results from such a mixed stand would be fairly typical of what might be expected from an application of the principles of the experiments on the average turpentine farm.

Fourth. It was necessary that consent should be given by the owners of the tract to the conduct of the operations in whatever manner the necessities of the investigation demanded.

After a careful survey of the field it was decided to locate the experiments at Walkill, Fla., on an ample tract of timber tendered by the Walkill Turpentine Co. This location met all the requisite conditions, and, in addition, was stocked with trees among which all of the different stages of growth were well represented. About 25,000 trees of size suitable for turpentining were embraced in the tract.

PLAN OF EXPERIMENTS.

The tract of timber was divided into four equal "crops," including about 8,000 chipping faces each. This number was adopted because experience showed that the average chipper in Florida was unwilling to chip a larger number each week, and it was of great importance that the working of each crop should be as regular as possible. In order to equalize the quality of the timber in the several crops, "drifts," or subdivisions of each crop (fig. 2) were alternated. The crops were designated A, B, C, and D.

Crop A was taken as the standard, the yield from which should form the basis of comparison with that of the other crops. In this crop it was sought to reproduce in every respect the normal methods employed on all ordinary crops of the Walkill Turpentine Co. The

yield of crop A would then represent the regular output of timber such as that found on the tract, under the usual methods of operation, modified only by weather conditions. A large number of preliminary observations were made in the crops of the company to determine the minimum size of the trees used for turpentining, the minimum diameter of trees having more than one cup, and the width, height, and depth of the chipped surfaces. On the basis of the data thus obtained, crop A was prepared for operation, and was worked regularly for four consecutive seasons.

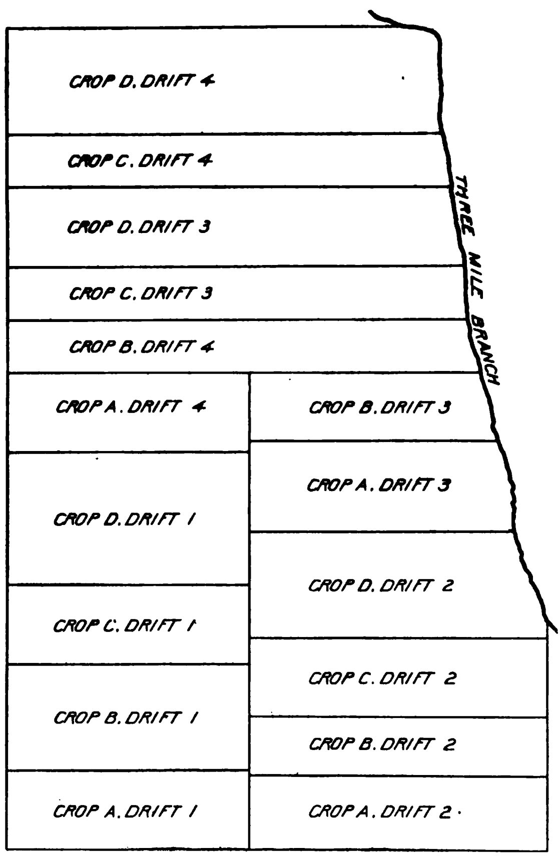

FIG. 2.—Divisions of experimental forest.

Crop B served to test the relative yield from more shallow chipping. In crop A the average depth of the cut in chipping, measuring from the inside of the bark, was seven-tenths of an inch; but in crop B this depth was decreased to four-tenths of an inch. All other conditions of the work, however, were identical with those of crop A. Consequently any variation in the yield from crop B, compared with crop A, would be attributable to this factor alone.

Crop C was used for tests to determine the relative yield from chipping which progressed more slowly up the trunk of the tree than in crop A. All other conditions were the same as in crop A. It was evident that if the yield from this crop proved even approximately the same as from crop A, this modification of chipping should make direct appeal to both turpentine operators and timber owners. If without diminishing the annual number of chippings, the height of the chipped surface on the trunk of the tree after four years is that usually reached in three, clearly a gain of one-third would be made for turpentining.

In crop D an entirely different line of investigation was undertaken. At present, when turpentining is begun on a tract of round timber, practically no thought is given to the possibility of working the timber a second time. The chief cause of this lies in the fact that in most cases the operations are conducted on timber leased for a limited number of years. These leases are usually based upon a certain rate per acre. As a result of this system the operator naturally seeks to get as much as possible from the timber during the short term his lease continues. This system of leasing, however, is being gradually replaced by ownership of the timber tracts, and in many cases the holdings are very large. To such owners the possibility of a second working of the timber at once presents itself as desirable. The purpose of crop D, therefore, was to determine the practicability of a second working of the same crop. In this crop the chipping was the same as in crop A; the minimum diameter of trees to be turpentined, 6 inches in crop A, was raised to 10 inches; the minimum diameter of trees to carry two chipping faces, 13 inches in crop A, was raised to 16 inches; and no tree in crop D carried more than two chipping faces.

The chief difficulty encountered in carrying out the experiments was the lack of exactness in the chipping. Ideal conditions demanded the use of a hack so modified that the depth or height of the cut would be regulated automatically by the tool and not depend upon the skill of the individual chipper, but such a hack was not then available.[1] However, by constant and close supervision the main ends sought were practically realized.

RECORDS KEPT.

YIELD OF GUM.

For collecting the gum, the cup system described in Bulletin 40 was used.[2] All of the cups were placed upon the trees by the same squad of laborers, thus insuring uniformity. At the close of each season the equipment in all crops was raised on the trunks and reset just where the chipping had stopped, so that conditions of collecting the gum would be practically the same each successive year. At regular intervals the gum from each crop was collected from the cups and placed in barrels having special marks. These barrels were hauled to the still and placed on a platform separate from that used for holding the regular product of the farm.

[1] Since these experiments were completed a turpentine hack has been invented which is designed to control automatically the depth of the streak cut.

[2] Since these experiments were begun other cup systems have been introduced into commercial use, and have received the approval of the Forest Service; it must be understood, therefore, that the use in the experiments at Walkill of one particular cup system is not to be regarded as an indorsement of this system to the exclusion of others which have also been found meritorious.—Henry S. Graves.

At the end of each day the net weight of the gum in each barrel was determined by the supervisor and the proper records made. No effort was made to distill the gum from the several crops separately, since no difference in the quality of the product was looked for.

WEATHER CONDITIONS.

To keep an accurate record of the daily temperature and rainfall throughout the four years was considered unnecessary, but to preserve a record of the general weather conditions, the supervisor recorded each week the approximate variations in temperature under the terms "cool," "warm," and "hot;" and instead of rainfall, the terms "dry," "showers," and "rain." A general idea of the average weather conditions during each of the four years can be given by assigning to each of the above terms a numerical value, thus:

Cool	1	Dry	0
Warm	2	Showers	1
Hot	3	Rain	2

On this basis, the average of the weekly records appear as follows:

TABLE 3.—*Average temperature and rainfall.*

Season.	Temperature.	Rain.	Season.	Temperature.	Rain.
1905	2.39	0.94	1907	1.83	0.76
1906	2.22	.62	1908	1.97	1.35

RESULTS OF THE EXPERIMENTS.

Table 4 gives a summary of the results of the investigation, the yield being expressed in net pounds of "dip" and of "scrape." By the term "dip" is meant the gum which is collected (dipped) from the cups. By "scrape" is meant the hardened gum which accumulates gradually during the chipping season on the scarified surface of the tree. At the end of the season this hardened mass is scraped from the tree. On distillation it yields about one-half as much spirits of turpentine as is obtained from a like quantity of dip. It is essentially a product of the long-leaf pine, the Cuban (slash) pine yielding practically no scrape. Detailed tables of yield will be found in the Appendix.

TABLE 4.—*Summary of chippings and yield, seasons 1905, 1906, 1907, and 1908.*

Year.	A			B			C			D		
	Chippings.	Dip.	Scrape.	Chippings.	Dip.	Scrape.	Chippings.	Dip.	Scrape.	Chippings.	Dip.	Scrape.
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*
1	31	63,615	9,570	31	61,162	7,650	31	62,587	7,245	31	73,704	8,888
2	35	64,583	12,795	35	62,309	12,469	35	63,172	10,411	34	81,672	13,765
3	29	43,675	10,209	30	50,534	9,742	30	50,875	8,207	26	62,119	11,006
4	30	34,362	15,168	27	35,633	13,772	28	37,861	13,240	28	48,716	17,342
Total	125	206,235	47,742	123	209,638	43,633	124	214,495	38,103	119	266,211	51,001

The proportion of long-leaf and Cuban pine in the different crops is shown in Table 5.

TABLE 5.—*Proportion of long-leaf and Cuban pine.*

Crop.	Cups on long-leaf pine.	Cups on Cuban pine.	Crop.	Cups on long-leaf pine.	Cups on Cuban pine.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
A	57	43	C	46	54
B	48	52	D	51	49

TABLE 6.—*Corrected estimate of dip and scrape on basis of number of chippings of crop A, seasons 1905, 1906, 1907, and 1908.*

Year.	A			B			C			D		
	Chippings.	Dip.	Scrape.	Chippings.	Dip.	Scrape.	Chippings.	Dip.	Scrape.	Chippings.	Dip.	Scrape.
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*
1	31	63,615	9,570	31	61,162	7,650	31	62,587	7,245	31	73,704	8,888
2	35	64,583	12,795	35	62,309	12,469	35	63,172	10,411	35	84,074	14,170
3	29	43,675	10,209	29	48,850	9,417	29	49,179	7,933	29	69,286	12,276
4	30	34,362	15,168	30	39,590	15,302	30	39,565	14,186	30	52,196	18,581
Total	125	206,235	47,742	125	211,911	44,838	125	214,503	39,775	125	279,260	53,915

TABLE 7.—*Summary of total yields, on basis of corrected dip and scrape.*

Crop.	Dip.		Scrape.		
	Yield.	Increase.	Yield.	Increase.	Decrease.
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*	*Per cent.*
A	206,235		47,742		
B	211,911	2.75	44,838		6.08
C	214,503	4.01	39,775		16.69
D	279,260	35.41	53,915	12.93	

In order that the results of these experiments should be of real use to turpentine operators, care was taken from the outset that the normal conditions of turpentine operations should prevail. For this reason the labor employed was no more skilled than that found from year to year on the farm of the Walkill Turpentine Co., and the ordinary wages were paid. This made it impossible to keep one set of workmen throughout the tests, since the hands are constantly shifting from one farm to another. The frequent changing of chippers resulted in an uneven number of total chippings in the several crops at the end of each season, as will be seen from the table.

In order, therefore, to render the yields more strictly comparable, in Tables 6 and 7 the yield from each crop is corrected on a basis of the chippings in the standard crop A. These corrections are not exactly accurate, as the calculations are based solely upon the number of chippings and do not take into consideration the season of the year. Nevertheless the corrected tables give a reasonably accurate comparison of the yield from the different experiments with an equal number of chippings.

LABORATORY EXPERIMENTS.

After the first year it was decided to supplement the field operations by laboratory studies. These were carried out in the chemical laboratory of the University of North Carolina by Mr. George A. Johnston, a collaborator of the Forest Service, under the direction of the writer.

Important results were derived from a comparison of the percentage of spirits of turpentine in the gum obtained from ordinary and from shallow chipping. Two trees (Cuban pine) were selected in each of crops A and B, one of medium and one of small diameter. All four trees were near each other, all were chipped on the same day, and the collection of the gum was made at regular intervals of four weeks. Special effort was made to select trees which corresponded in general character of crown. For collecting the gum, oyster pails were used instead of the ordinary turpentine cups, as these could be securely sealed by their own covers and shipped with safety. New pails were used for each collection of gum. The scarified faces of the trees, together with the pails, were protected from sunlight, rain, and impurities such as chips, sand, etc., by a heavy oilcloth. After each chipping, the gutters were raised only to the chipping surface in order to maintain a uniform distance of flow for the gum in the successive periods. The pails containing the gum were promptly expressed to the laboratory, where each specimen was distilled and the per cent of spirits of turpentine determined. Due precautions were taken to prevent the mechanical carrying over of particles of

resin with the spirits of turpentine. The results of these experiments are given in Table 8.

TABLE 8.—*Per cent of spirits of turpentine obtained by deep and by shallow chipping.*

Dipping.	Deep chipping. Tree No. 1, 13 inches diameter.	Deep chipping. Tree No. 2, 9 inches diameter.	Shallow chipping. Tree No. 1, 12.3 inches diameter.	Shallow chipping. Tree No. 2, 8.2 inches diameter.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*
1	23.50	21.47	21.84	19.64
2	20.26	19.32	22.82	21.01
3	18.60	18.61	21.23	18.86
4	18.52	17.23	21.26	19.77
5	16.43	18.75	21.38	19.36
6	17.93	18.44	21.75	20.13
7	15.47	17.44	21.59	[1] 17.92
Average	18.67	18.47	21.90	19.53

[1] The low result obtained on the seventh dipping of shallow-chipped tree No. 2 was probably due to an analytical error, but not enough gum remained for a second determination of this result.

From these figures it will be seen that in the case of deep chipping a fairly steady decrease in the per cent of the spirits of turpentine characterized each successive chipping, while with shallow chipping the per cent was practically constant throughout the season. Moreover, if an average is taken of the figures for the two deep-chipped trees and another of those for the two shallow-chipped trees, the result will be seen to be for deep chipping 18.57 per cent and for shallow chipping 20.71 per cent, an increase in favor of shallow chipping of approximately 11 per cent.

At the end of the second season a careful study was made of the condition of the trees in the first and second drifts of each crop. The count of the dead trees is shown in Table 9.

TABLE 9.—*Number of dead trees in the different half-crops at end of second season.*

Half crop.	Long-leaf pine.	Cuban pine.	Total.
A	59	62	121
B	45	28	73
C	51	13	64
D	48	10	58

The measurement of "dry face" (nonproductive surface developed during operations) showed the average width per chipped face given in Table 10.

TABLE 10.—*Average width of dry-faces developed in the different half-crops during operations.*

Half crop.	Long-leaf pine.	Cuban pine.	Average.
	Inches.	*Inches.*	*Inches.*
A	1.2	2.2	1.6
B	.8	1.0	.9
C	0.9	1.7	1.2
D	1.1	1.5	1.3

The number of chipped faces which had been abandoned on account of complete "dry face" is shown in Table 11.

TABLE 11.—*Number of chipped faces in the different half-crops abandoned on account of dry-face.*

Half crop.	Long-leaf pine.	Cuban pine.	Total.	Half crop.	Long-leaf pine.	Cuban pine.	Total.
A	50	86	136	C	37	45	82
B	31	57	88	D	50	20	70

DISCUSSION OF RESULTS.

Crop A.—From the results given in Table 4, page 13, it is seen that the yield from this standard crop in successive years follows closely the relative decrease noted in the experimental crop at Ocilla, Ga., described in Circular 34 of the Forest Service.

The increase of the second year over that of the first is of course to be explained by the greater number of chippings, 35 as against 31. On a basis of the same number of chippings, the usual slight decrease in the yield of the second year is observed. But after the second year the effect of the chipping in decreasing the vitality of the trees and in increasing the amount of "dry face" is shown by the marked decrease in yield.

The striking fluctuation in the yield of scrape in the third and fourth years, shown also in crops B, C, and D, may have been partly due to the weather conditions, since reference to Table 3, page 12, indicates an unusually low temperature in the third year and an unusually heavy rainfall in the fourth year. It would seem, however, that this uniform and unexpected fluctuation must have been due chiefly to some cause which affected the character of the crude turpentine's crystallization. Ordinarily the quantity of scrape would be expected to increase each year.

The count of the dead trees at the end of the second year showed a much greater number in crop A than in any of the others, while the average width of dry face per chipped face was also largest. This was to be expected, since in this crop chipping conditions were relatively most severe. Measured from the inside of the bark, the chipping of long-leaf pine in this crop showed an average depth of seven-tenths of an inch. It must be borne in mind, however, that such chipping does not represent the extreme depth of actual practice, for in many cases the cut is made from 1 to 1½ inches deep.

Crop B.—This crop was intended to test the yield from shallow chipping. Measurements of the depth of the chipping compared with the standard crop A are given in Table 12.

TABLE 12.—*Comparative depth of chipping, crops A and B.*

Crop.	Depth of chipping on—	
	Long-leaf pine.	Cuban pine.
	Inch.	*Inch.*
A	0.7	0.6
B	.4	.3

In spite of this great diminution in the depth of the chipping (approximately one-half) the total yield of dip from crop B in four years of operation was about 3 per cent greater than from the standard crop. The first and second year's yield showed a slight decrease, compared with crop A, but in the third and fourth years the yield was sufficiently in excess to make the total in favor of shallow chipping. No explanation seems possible for this other than the greater vitality of the trees which had been wounded less deeply (see frontispiece). In the third year the yield from crop B decreased only 20 per cent from that of the first year, as against a falling off in crop A of 31 per cent.

The total yield of scrape is less in the shallow chipped crop than in the standard, but this is insufficient in quantity and too poor in quality to offset the yield in dip. This decreased yield of scrape is in accord with the prevailing view among turpentine operators that deep chipping results in a larger scrape yield than shallow chipping. It is impossible to explain, however, why two-thirds of the decrease occurred in the first year, while the yields in the second and fourth years were approximately the same in both crops.

The count of dead trees at the end of the second year showed 40 per cent fewer in the shallow-chipped than in the standard crop. The larger part of this decrease in the number of dead trees, as was to be expected, was in the Cuban pines. Measurements at the same time showed 44 per cent less dry face on the shallow-chipped crop. These decreases are far more striking than the mere percentages would indicate, because it is generally in the third and fourth years that the injury inflicted upon the trees in the turpentining process begins to produce heavy losses from death of trees and formation of dry face. Indeed, the great decrease in production in the fourth year under the boxing method may be ascribed in large measure to the great amount of dry face formed. It has already been remarked that the gain made by crop B over crop A in yield of dip did not show itself until the third year. Had it been possible to make the count of dead trees and measurements of dry face at the end of the fourth

year, instead of at the end of the second merely, there is every reason to believe that the difference in favor of shallow chipping would have been very much greater.

The results obtained from this crop are very striking. At the outset, the best hoped for was that there should be such a slight decrease in yield that it would be more than offset by the better condition of the timber after turpentining. The beneficial effect of this style of chipping upon the timber is shown by the facts given above, but instead of a slightly decreased yield of crude turpentine there has been an actual increase.

The results leave no doubt as to the wisdom of shallow chipping.

Crop C.—The approximate cessation of flow of crude turpentine within one week after chipping is due to stoppage of the mouths of the resin ducts by crystallization and oxidation of the gum. The question of the width of the cut necessary to reopen these ducts resolves itself simply into a determination of the extent of this stoppage.

It was intended to reduce by one-half the width of the cut in chipping this crop, but this was found to be impracticable. In spite of continued urging and the closest supervision, the chippers invariably made the cut wider than was desired. This fact is undoubtedly to be ascribed to the character of the free arm swing used in chipping. To make a further reduction in the width of the cut possible, it would seem that some modified form of the present hack must be used. Nevertheless, in spite of the failure to reduce the width of the cut as much as desired, a considerable decrease was made. Measurements of the height of the face at the end of the fourth year in this crop and in the standard crop are given in Table 13.

TABLE 13.—*Height of chipped face at end of fourth year, crops A and C.*

Crop.	Height of chipped face.
	Inches.
A	64.3
C	50.0
	14.3

Such a saving means another year's use of the timber for turpentining. This gain of a fifth year might be a questionable one, on account of the relatively smaller yield in the later years of operation, if it had been made at a cost of a considerable decrease in the yield during the first four years, but the results show that instead of a decrease there was an actual increase greater than that shown in crop B.

From Table 6, page 13, it is seen that the most marked difference in comparison with crop A is in the third year.

The comparatively beneficial effect of this manner of chipping is shown in the count of dead trees at the end of the second year, this crop showing 47 per cent fewer than the standard crop A.

On the other hand, while the results showed 33⅓ per cent more "dry face" than in crop B, still there was a decrease of 25 per cent in comparison with crop A, the depth of chipping in crops A and C being the same.

By the method followed in crop C another advantage is gained, in that because of the slower ascent of the trunk it is entirely practicable to chip the trees during the first three years with the hack, whereas, under ordinary conditions, the height of the chipping surface makes it necessary to "turn the trees to the puller" during the third year. Pulling is usually considered more difficult work than chipping, and, consequently, turpentine operators experience difficulty in getting labor to work such crops. While to operate on timber for four or five years it would still be necessary to "pull" the trees during the fourth year, certainly an advantage is gained in carrying the chipping through the first three years, and thus avoiding the usual difficulties with the laborers. Where the operator holds but a three years' lease of timber, this objectionable feature is entirely removed.

The results obtained on this crop are of importance to both turpentine operators and lumbermen—to the former on account of the increased yield and prolonged use of the tree; to the latter because 14 inches less of the butt log is scarified after four years of turpentining.

In this crop, as in crop B, these advantages were obtained without any extra cost, and without the introduction of revolutionary methods. It is only necessary that the supervising woodsman require the chippers to make the necessary reduction in the width of the cut.

Crop D.—From the outset an increased yield, compared with the standard crop, was expected from crop D. These expectations were based upon the facts that in this crop no trees less than 10 inches in diameter were turpentined, and, furthermore, that on the larger trees the number of chipping surfaces was diminished, thus leaving a relatively greater proportion of the circumference of the sapwood uninjured. Such trees should, in consequence, have greater vitality, and produce greater quantities of crude turpentine.

The expected increase in yield of dip was evident at the end of the first year, crop A yielding, by the corrected estimate presented in Table 6, 63,615 pounds and crop D 73,704 pounds. But of greatest interest was the total for the four years of only 206,235 pounds from crop A, as against 279,260 pounds from crop D, a gain for the latter of 73,025 pounds, or 35 per cent, in the total yield of dip during the four-year period.

TABLE 14.—*Gain of dip, by years, from crop D.*

Year.	Dip.		Increase.	
	A.	D.	Pounds.	Per cent.
	Pounds.	*Pounds.*		
1	63,615	73,704	10,089	16
2	64,583	84,074	19,491	30
3	43,675	69,286	25,611	58
4	34,362	52,196	17,834	52

There was, in addition, a gain in scrape from crop D in the four years of 6,173 pounds, or 13 per cent, over the scrape from crop A.

The relative yields in the last three years, calculated upon a per cent basis of the yield of dip in the first year in each, are shown in Table 15.

TABLE 15.—*Comparative yields of dip from crops A and D during last three years of operation in terms of percentage of yield during first year.*

Year.	Crop A.		Crop D.	
	Increase.	Decrease.	Increase.	Decrease.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Second	1½		14	
Third		31		6
Fourth		46		29

The full significance of the results is shown in the following diagram (fig. 3), in which the total yields of dip from the beginning of operations are plotted, the dotted lines representing crop A, the solid line crop D.

These results show plainly that the conservative methods applied in crop D enable the trees more nearly to maintain their normal efficiency. While a part of the rapid decrease of the third and fourth year yields from crop A can be ascribed to the exhaustion of the very small trees, it would seem to be due principally to a rapid loss of producing power in practically all of the trees in this crop. In crop D this loss is largely overcome, at least for the first three years. Nevertheless, the large decrease in crop D in the fourth year shows that the policy adopted in this crop is even yet not sufficiently conservative.

Crop D at the end of the second year showed a smaller number of dead trees than any of the other three crops, a natural result from their more conservative treatment.

The chipping in this crop was exactly the same as in the standard crop, and it is seen from the table that the average width of dry face per chipped face is less than in the standard crop, another result of

the conservative use of the trees. However, it is greater than in either crop B or crop C, where the chipping was not so severe.

Finally, in one-half of crops A and D careful count was made of the number of cups which could be placed in the same territory for a second working. The results are shown in Table 16.

TABLE 16.—*Number of cups which could be placed on crops A and D for second working.*

Half crop.	On trees above 10 inches diameter.	On trees between 6 and 10 inches diameter.	Total.
A	1,513	19	1,532
D	2,287	1,341	3,628

In brief, by following the method of crop D, the following advantages are gained:

First. Considerably more gum is received from each chipped face, and this without extra cost.

Second. The largest part of the capital in a turpentine farm is invested in a reserve supply of timber for future operations, and upon such investment a heavy interest charge soon accrues. Under the policy indicated in crop D, with its largely increased yield, a quicker cancellation of this debt and heavy interest charge is obtained, while under the policy followed in crop A the available labor is, at least to some extent, engaged in working small trees whose product scarcely more than pays for the cost of their operation.

Third. The number of trees that are killed is largely decreased.

Fourth. The smaller trees will have at least four years more growth before they are turpentined, and on account of their greater vigor and maturity will necessarily be better producers.

Fifth. The cost of second operation in the territory of crop D will not be increased. A count showed space available for practically as many cups as on the first working, while in crop A a second working would be so scattered that labor expenses would prohibit even the "back cupping" of such timber.

The policy underlying the method of operation of crop D is not a truly conservative method of turpentining, but only an approach toward one. With the rapidly approaching exhaustion of the pine forests the time is now at hand when a tract of timber must be viewed with the possibility of its being turpentined more than once, and it is believed that the results from crop D point the way.

EXPERIMENTS WITH COMBINED SHALLOW AND NARROW CHIPPING.

It was decided, just at the beginning of the 1908 season, to test, on two or more crops, methods of chipping which should combine

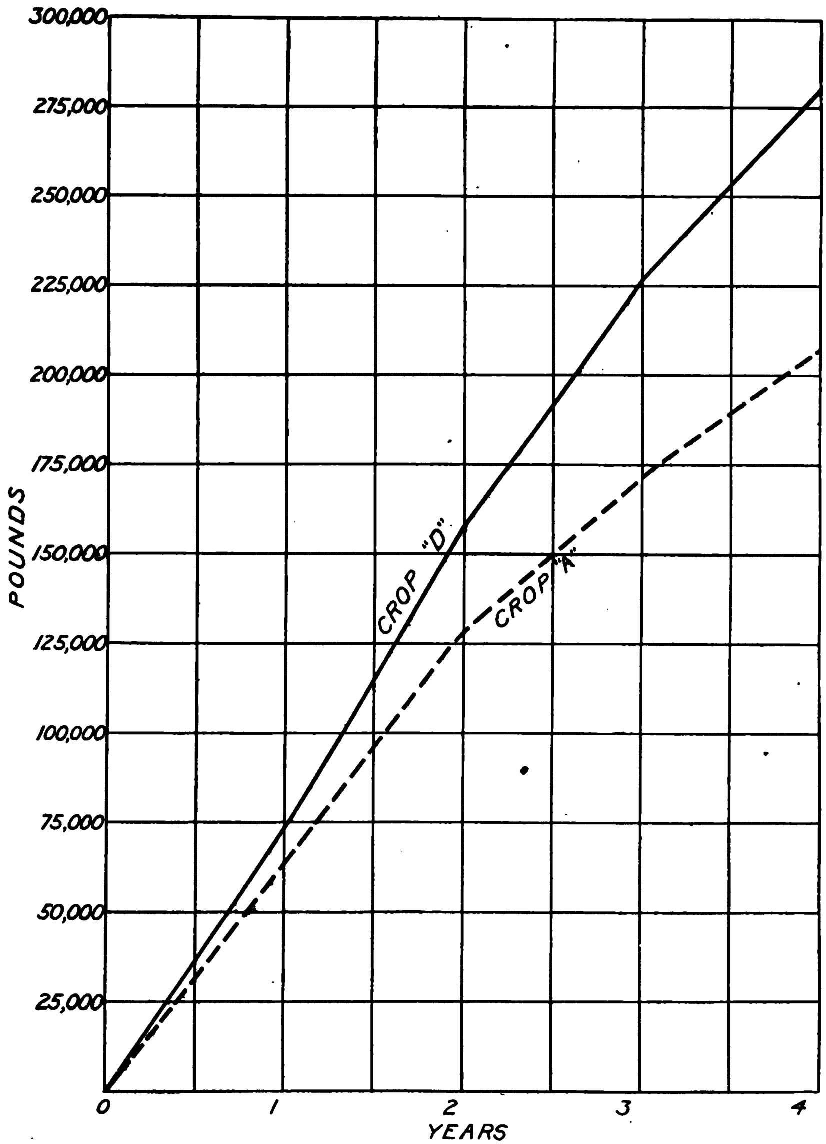

FIG. 3.—Comparative yields from crops A and D.

the methods used in the previous experiments; namely, shallow depth and slow ascent of the trunk of the tree. For this purpose two crops of cups, placed upon round timber during the previous

winter by the Walkill Turpentine Co. in the regular course of their operations, were made available, and were designated crops G and H. A summary of the results from these two crops is given in Tables 17 and 18:

TABLE 17.—*Crop G dippings, 1908.*

No.	Begun.	Finished.	Number of barrels.	Net pounds.	No.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 22	Apr. 27	26½	10,912	6	Oct. 12	Oct. 20	28	12,031
2	May 25	May 29	29	12,043	7	Dec. 15	Dec. 23	30	12,708
3	June 23	June 30	29	12,304					
4	July 24	July 31	37	16,450	Total.			208½	88,679
5	Sept. 7	Sept. 23	29	12,231					

Number of chippings, 32. Scrape, 6,375 pounds.

TABLE 18.—*Crop H dippings, 1908.*

No.	Begun.	Finished.	Number of barrels.	Net pounds.	No.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 22	Apr. 26	29½	12,636	6	Oct. 12	Oct. 20	28	11,875
2	May 21	May 25	27	11,529	7	Dec. 15	Dec. 23	31	12,860
3	June 23	June 30	29	12,222					
4	July 28	Aug. 2	32	13,023	Total.			212½	88,524
5	Sept. 7	Sept. 19	36	14,379					

Number of chippings, 30. Scrape, 6,805 pounds.

The yield from crops G and H was compared with that from an adjacent crop of the company chipped deep in the customary manner. This latter crop consisted of 9,880 cups, was chipped 35 times, and yielded 214 barrels of crude turpentine. From the results obtained in crops G and H it was calculated that 1 barrel contained 421 pounds of crude turpentine. At the same rate, the 214 barrels contained 90,094 pounds. No record was available for the amount of scrape gathered from this crop.

TABLE 19.—*Actual yield from crops G and H compared with that from adjacent crop.*

Crop.	Number of cups.	Number of chippings.	Yield.	
			Dip.	Scrape.
			Pounds.	*Pounds.*
Walkill Turpentine Co.	9,880	35	90,094	(1)
G	7,710	32	88,679	6,805
H	8,400	30	88,524	7,259

[1] No record.

From Table 19 it is seen that the number of cups in each of these crops was different. For the purpose of comparison, the yields should be calculated on a basis of the same number of cups, each yielding the quantity actually averaged by the cups set. Such a calculation gives the results shown in Table 20.

TABLE 20.—*Corrected yield from crops G and H compared with that from adjacent crop.*

Crop.	Number of cups.	Number of chippings.	Yield of dip.
			Pounds.
Walkill Turpentine Co.	9,880	35	90,094
G	9,880	32	113,638
H	9,880	30	104,121

Finally, to be strictly comparable, the yield from each of the several crops should be calculated on a basis of an equal number of chippings in each crop. This would give the data shown in Table 21.

TABLE 21.—*Corrected yield from crops G and H and from adjacent crop on basis of equal number of cups and chippings.*

Crop.	Number of cups.	Number of chippings.	Yield of dip.	Increase.
			Pounds.	*Per cent.*
Walkill Turp. Co.	9,880	35	90,094	....
G	9,880	35	124,292	38
H	9,880	35	121,474	35

This striking increase of yield in crops G and H is plainly to be ascribed to the decreased severity of the wound given in chipping, both in height and in depth. It demonstrates that the general adoption of such modifications of chipping benefit the sawmill and turpentine operator: The first, because of the better grade of timber from the butt cut and the smaller number of dead trees in the tract; the second, because of the largely increased yield of crude turpentine and the prolonged use of the tree.

Since it has been demonstrated in the crops discussed that the increased yield under a system of shallow chipping, as to either height or depth, is found in the third and fourth years of operation, it can safely be assumed that, with a system of chipping which combines shallowness both in depth and height, as followed for a single year in crops G and H, the average per cent of increase for four years of operation would be even larger than the 35 to 38 per cent obtained in the first year.

The full significance of the chipping experiments appears only when they are considered as a whole. Either shallow chipping or narrow chipping, applied by itself, secured a relatively small, though nevertheless valuable, increase in yield of dip (2.75 per cent for shallow chipping in four years, and 4 per cent for narrow chipping). As a partial offset against this increase, however, must be noted a decreased yield of scrape amounting in the same period to 6.08 per cent for shallow chipping and 16.69 per cent for narrow chipping. Laboratory analyses showed that the dip from shallow-chipped trees in the second

year was about 10 per cent richer in turpentine than ordinary dip; and there is no reason why a similar result should not be expected in the case of narrow-chipped trees also. In addition to securing a somewhat larger quantity of decidedly more valuable dip, there was evident at the end of the second year a heavy reduction in the loss from dead trees and faces abandoned because of dry face—a reduction which presumably would have been found to be much more important at the end of the fourth year. Further narrow chipping established that by its use a crop might be worked for at least five years without extending the face farther up the tree than is customary in four years of ordinary chipping. To this extension of the period of turpentining through the possibility of advancing more slowly up the tree must be added the extension which can undoubtedly be counted on from the conservation of the tree's vitality, which means that, under properly adjusted methods, the same trees could be backcupped for a second working.

Finally, and most important of all, come the two discoveries of a greatly increased yield obtainable through (1) combined narrow and shallow chipping and (2) "light cupping"—that is, cupping no trees under 10 inches in diameter, putting two cups only on trees over 16 inches in diameter, and never putting more than two cups on one tree. The combined narrow and shallow chipping, tried for only one year, showed an increased yield of dip of between 35 and 40 per cent in the single season; and in all experiments with improved methods of turpentining which have been conducted for a four-year period the principal gain has been found to be in the later years. The light cupping method showed an increased production of dip in four years amounting to 35 per cent, and in addition left the timber in condition to be immediately worked again for a second four-year period—and perhaps by using conservative methods to turpentine the same tract indefinitely, and at the same time to get more turpentine than is produced by the destructive methods.

DISCUSSION OF THE CAUSE OF RESIN FLOW.

Among turpentine operators great difference of opinion exists as to the seat of resin production and the conditions which govern its flow. By some resin is thought to be formed in the leaves, while others hold that it is produced in the roots. Still a third view is that it exists already formed in the trunk of the tree, from which it drains after chipping. Another cause of confusion arises from the common belief that crude turpentine is the sap of the pine. The error in this last belief is easily demonstrated when it is remembered that the sap of the tree consists of water containing mineral substances in solution, while crude turpentine as it exudes from the tree contains no water,

and when burned leaves no ash—a proof of the absence of mineral matter.

To botanists it has long been known that resin occurs in small vessels or canals in the wood called "resin ducts," but during the past few years interesting studies upon the seat of resin production and the nature of resin flow have been made by Prof. A. Tschirch, of the University of Berne, Switzerland. The great difficulty in previous microscopic study of the pine wood has been the fact that in cutting thin sections of the wood, the resin has been smeared over the surface so that it was impossible to gain an accurate idea of the structure of the resin ducts. But by slowly drying the wood specimens at a moderate temperature, Prof. Tschirch has succeeded in hardening the crude turpentine in the resin ducts so that sections could be cut without smearing the surface. By carefully dissolving the resin of these sections in proper solvents, and by a subsequent application of a stain, Prof. Tschirch has been able to demonstrate that the seat of resin production is in a mucilaginous layer lining the inside wall of the duct (fig. 4).

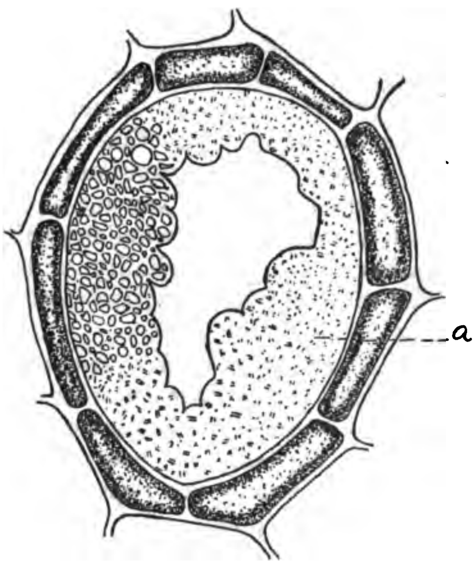

Fig. 4.—Resin ducts—Magnified cross section showing living membrane which produces resin.

By further studies carried out upon a large number of pine trees in the neighborhood of Berne, Prof. Tschirch demonstrated that, in the untapped pine, resin ducts occur scattered through both the heart and sapwood (fig. 5), but in a very limited number, varying in different trees of the same species. These resin ducts he calls "primary resin ducts," and the resin which flows from them when they are cut is a

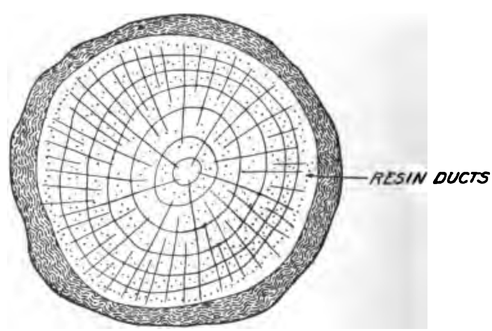

Fig. 5.—Cross section of pine stem showing distribution of primary resin ducts.

purely physiological product. The flow from such primary resin ducts is extremely limited. However, after a tree is wounded there at once begins in the outer sapwood the formation of numerous and much larger "secondary resin ducts" (fig. 6), which pour out crude turpentine over the wounded surface as a healing balsam. This resin is a pathological product. These secondary resin ducts, which constitute the chief source of commercial crude turpentine, form both above and below the wound, the length of those above the wound being greater than those below it. Viewed in a longitudinal tangential section, they appear as a network of tubes (fig. 7). Gradually the mouths of these resin ducts become clogged, presumably from oxidation and crystallization of the resin, and the flow ceases. Hence the necessity of chipping to reopen the ducts.

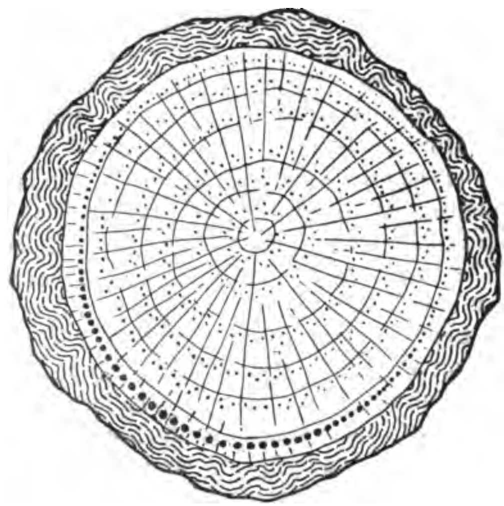

FIG. 6.—Cross section of a pine stem showing distribution of secondary resin ducts.

GAIN FROM WINTER CHIPPING OF CUPPED TREES.

A striking confirmation of this theory has been furnished within the past two years in connection with the operation of the cup system.

FIG. 7.—Secondary resin ducts.

The chief criticism directed against this new system has arisen from the common experience that, although the total yield from the first year of the operation is greater than under the box system, nevertheless an unusually large number of weekly chippings has been found necessary to secure the first dipping from cups—six to seven chippings, as compared with four chippings under the box system.

In the light of Prof. Tschirch's discovery concerning resin flow, the explanation of this shortcoming of the cup system is very simple.

Under the box system, the box is cut during the winter months, and in the late winter the trees are "cornered," giving wounded surfaces as shown in Plate III. The trees then usually stand for several weeks without further wounding. Immediately after cornering the formation of secondary resin ducts begins at all points of the cut (fig. 8). Later, when the tree is chipped, these secondary ducts are opened along the full length of the cut (fig. 9), and a good yield is consequently at once obtained. But in placing the cups during the winter, as described in Circular 34 of the Forest Service, it is the practice to make with the broadax two flat faces, meeting at the center, on which the cuts for insertion of the gutters are made (Pl. III). The upper portions of these faces have oval outlines (fig. 10). The formation of the vertical secondary resin ducts begins at once, and continues during the succeeding weeks, following the outline of the curved upper edges of the faces (fig. 10). At the beginning of the chipping season, the first chipping is made from each side to the center, the outer edge being considerably higher than the center. The result of this is that only the secondary resin ducts near the center of the face are cut (fig. 11), and consequently the bulk of the resin flow during the first few weeks of chipping comes almost entirely from this limited central area. Assuming the correctness of this theory, the solution of the difficulty is extremely simple; namely, during the winter months, when the gutters are placed upon the trees, the chipper should make a regular chipping, the full width of the face (fig. 12), to be scarified during the following season. Thus the vertical secondary resin ducts will be formed along the entire length of this cut, so that in the spring the first regular chipping would open the full number of these ducts (fig. 13).

During the winter of 1906–7 this theory was presented to a number of turpentine operators who were using the cup system with the request that they test its correctness. In every case the tests were thoroughly successful, the yield from the first dipping exceeding that from cups placed without the winter chipping or from boxed trees which had been cornered.

The importance of this to the turpentine industry is obvious. One extra dipping is gained by this modified method of placing the cups on round timber, which means about 30 barrels of crude turpentine per crop of 10,000 cups. Valuing this crude turpentine at $10 per barrel, the financial gain per crop is $300. As the number of the "virgin," or first-year crops of cups placed during the winter approximated 1,350, this represents a financial gain of approximately $405,000, the only charge against this gain being the one extra cost of chipping during the winter.

The same explanation doubtless holds good for the common experience among turpentine operators that boxes cut very late in

FIG. 1.—BOXED AND CORNERED TREE.

FIG. 2.—CUPPED TREE BEFORE CHIPPING.

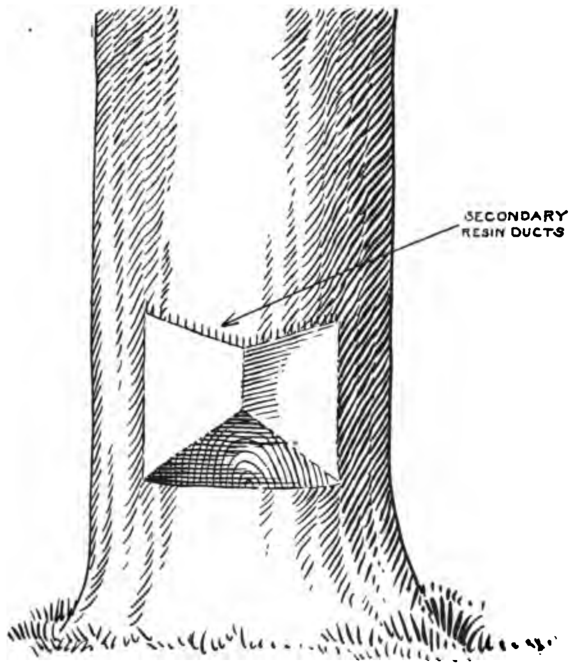

Fig. 8.—Formation of secondary resin ducts after boxed tree is cornered.

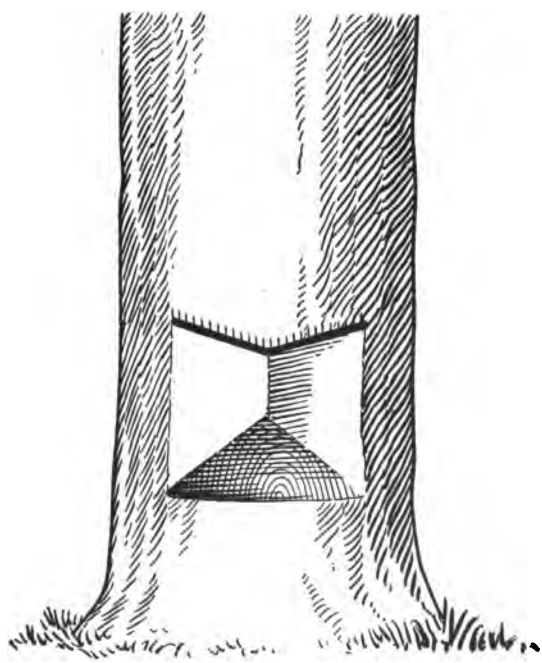

Fig. 9.—How the first streak in chipping boxed tree cuts through all of the secondary resin ducts.

the winter do not give a good yield during the early spring. The shortcoming is not due to the lateness of the box cutting, but to the consequent lateness of the cornering, and the fact that there is not time enough before chipping begins to permit the full formation of the secondary resin ducts above the cut made in cornering.

CONCLUSIONS.

Taken as a whole, the chipping experiments appear to demonstrate conclusively that if turpentine operators will adopt the methods which have now been proved to be practicable they will (1) substantially increase the yield per crop of crude turpentine obtainable in a four-year period; (2) make possible the indefinite prolongation of the turpentining period; and (3) cause far less sacrifice of merchantable timber.

The results of these studies taken in combination with the results already demonstrated as following the substitution of the cup for the box point toward a revolutionary change in the turpentine industry. Fully realized, this change is nothing less than a prospect of being able to turpentine a given tract permanently, just as a maple sugar orchard may be permanently worked for an annual output of sugar. This does not mean, of course, that the same trees will be turpentined forever, or that turpentining will be an alternative to lumbering. What it means is that the period of turpentining each crop of trees can be so prolonged that, with a proper system of forest management, a given tract can be turpentined continuously, younger trees growing up while the older crops of trees are being turpentined and the latter are finally removed by lumbering to make room for still another tree generation.

That this is not regarded as an unrealizable ideal is evidenced by the fact that the Forest Service is actually preparing to turpentine Choctawhatchee National Forest timber for the purpose of securing precisely these results. By taking care to conduct the operations with a view to inflicting the least possible wound upon the trees, by not turpentining trees under 12 inches in diameter, and by restricting carefully the number of cups to be placed on each tree, it is confidently expected that the turpentining can go on with trivial loss in the eventual yield of merchantable timber, that it can be continued on the same area indefinitely, gradually being extended to new trees as the smaller ones grow large enough for cupping, and that, when the time comes for lumbering, this will be followed by reproduction, which will grow up while operations are being conducted on other areas.

If this plan works out as expected, the Choctawhatchee National Forest will be continuously yielding turpentine, continuously producing lumber, and continuously renewing itself.

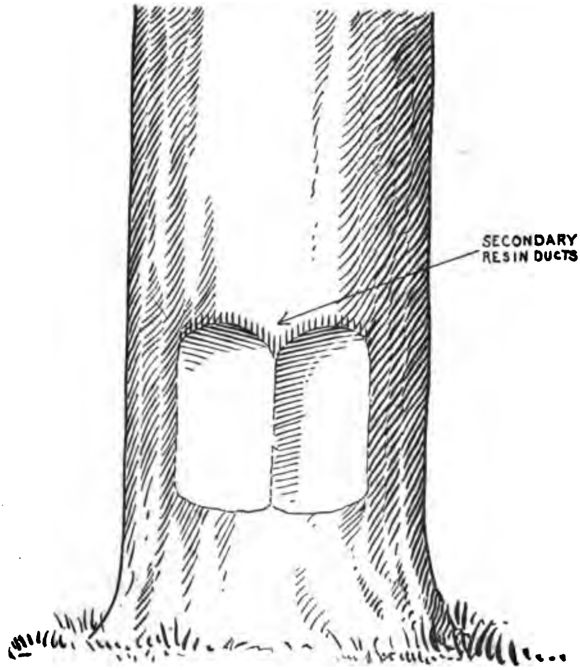

Fig. 10.—Formation of secondary resin ducts within from three to four weeks after a cupped tree is faced.

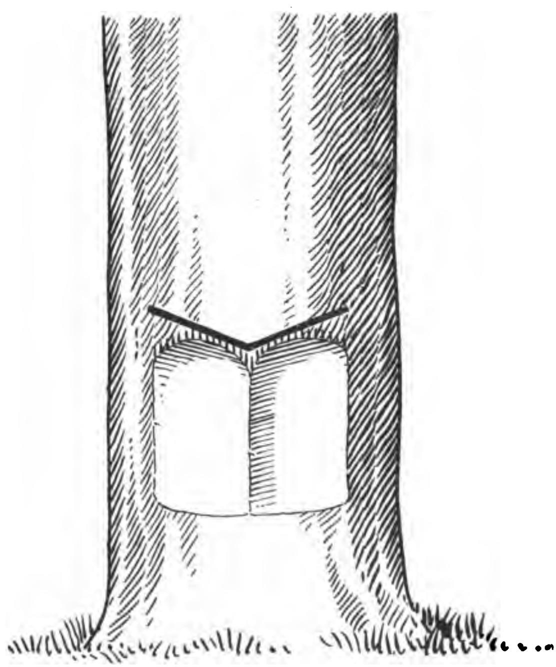

Fig. 11.—How the first streak in chipping tree faced for cupping cuts through few of the secondary resin ducts.

Such management of a pine forest, however, may require some readjustment of the views of the owner. At present he counts on a considerably larger number of crops from a given tract of timber than can be obtained by the management indicated as most profitable in the long run. It will be seen by looking at figure 2 that both half crops of crop D cover a considerably larger area than other half crops. Inasmuch as no trees under 10 inches in diameter were turpentined and not over 2 cups were put on any tree, while only 1 cup was put on trees between 16 and 10 inches in diameter, it is quite evident why a larger area is required for a crop. To set over against this smaller number of crops to a given tract, however, the owner would have the following gains:

(1) As it becomes demonstrated that a materially increased annual output per crop can be obtained under a method which combines cupping, light chipping, and light cupping (that is, restricting the operation to timber over 12 inches in diameter, and closely limiting the number of cups per tree), a larger annual rental per crop will naturally be obtainable.

(2) By prolonging the period during which a crop can be worked, there can be secured the equivalent of a rental for a longer period.

(3) By exempting the younger trees from turpentining until they have reached a size at which they can be worked, a further prolongation of the working period will be secured.

In short, it may now be regarded as established that, instead of being a self-destroying industry, bound to disappear from the South before many years because of the exhaustion of the timber available for turpentining, the naval stores industry, after having retreated southward and westward because its material in the older regions gave out, is now in prospect of becoming stable throughout the present southern pine belt.

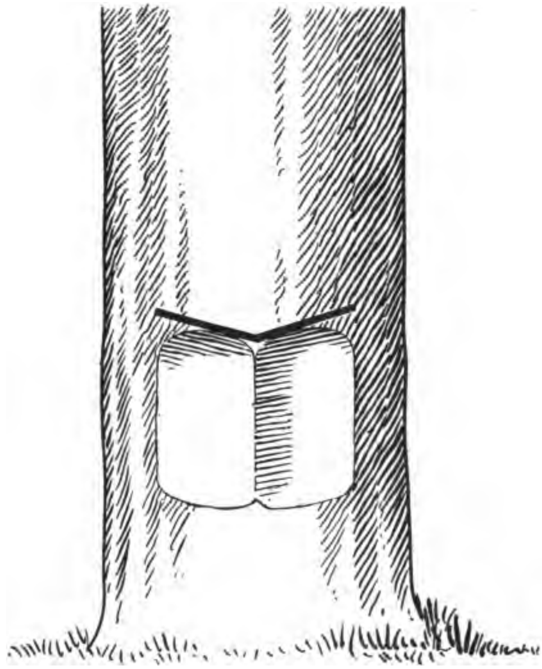

FIG. 12.—A tree with preliminary streak chipped at time of facing.

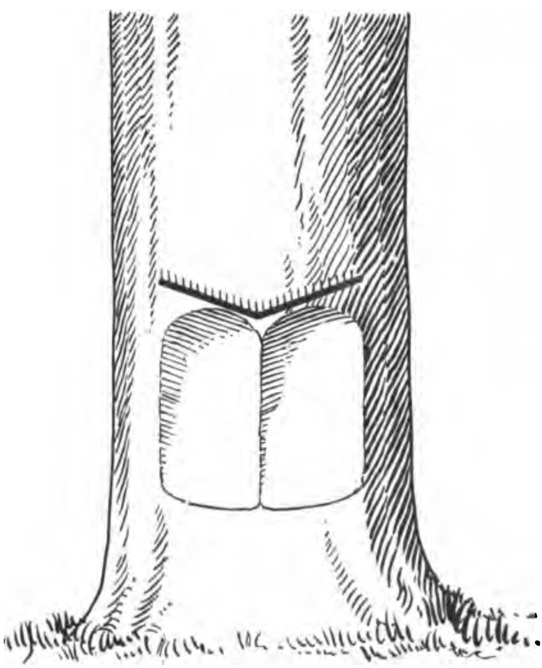

FIG. 13.—Formation of secondary resin ducts following the preliminary streak, previous to the first regular chipping.

APPENDIX.

Crop A dippings.

No.	1905				1906			
	Begun.	Finished.	Number of barrels.	Net pounds.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 24	May 8	14⅝	6,102.5	Mar. 27	Apr. 11	21	8,673.5
2	May 23	June 8	22	9,248.5	May 1	May 18	26⅝	11,136.5
3	June 20	July 10	25⅞	10,875.5	June 8	July 6	29⅞	13,038.0
4	July 24	Aug. 10	24¼	10,421.0	July 19	Aug. 16	28	12,234.0
5	Aug. 28	Sept. 18	23¾	10,167.0	Sept. 12	Oct. 4	25	10,903.5
6	Sept. 28	Oct. 23	21⅞	9,404.0	Nov. 9	Nov. 14	19⅞	8,597.5
7	Nov. 18	Nov. 28	17¼	7,397.0	....	....	....	....
Total	....	....	149⅝	63,615.5	....	....	150⅝	64,583.0

1905. Number of chippings, 31. Scrape, 9,570 pounds.
1906. Number of chippings, 35. Scrape, 12,795 pounds.

No.	1907				1908			
	Begun.	Finished.	Number of barrels.	Net pounds.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 9	May 6	21	8,994.0	Apr. 18	Apr. 20	15⅛	7,014.0
2	May 17	June 14	18⅞	8,091.0	May 25	May 29	16⅛	7,090.0
3	July 3	July 30	21¼	9,316.0	July 28	July 29	16	6,964.0
4	Aug. 23	Sept. 12	20¾	9,145.0	Sept. 1	Sept. 16	19	8,086.0
5	Oct. 20	Nov. 2	19½	8,129.0	Nov. 10	Nov. 15	13	5,208.0
Total	....	....	100⅞	43,675.0	....	....	79¼	34,362.0

1907. Number of chippings, 29. Scrape, 10,209 pounds.
1908. Number of chippings, 30. Scrape, 15,168 pounds.

Crop B dippings.

No.	1905				1906			
	Begun.	Finished.	Number of barrels.	Net pounds.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 27	May 19	14⅝	6,131.5	Mar. 30	Apr. 13	22⅜	9,226.5
2	May 25	June 12	21⅝	9,023.0	May 4	May 30	25⅞	10,775.0
3	June 26	July 14	23½	10,101.5	June 15	July 12	28⅝	12,184.5
4	July 26	Aug. 16	23⅞	10,117.5	July 25	Aug. 24	27½	11,918.0
5	Sept. 4	Sept. 20	26⅜	11,140.5	Sept. 17	Oct. 5	13¾	10,270.0
6	Oct. 3	Nov. 17	23	9,812.5	Nov. 9	Nov. 14	18⅞	7,934.5
7	Nov. 24	Nov. 27	11⅛	4,835.0	....	....	....	....
Total	....	....	144⅛	61,161.5	....	....	147	62,308.5

1905. Number of chippings, 31. Scrape, 7,650 pounds.
1906. Number of chippings, 35. Scrape, 12,468.5 pounds.

Crop B drippings—Continued.

No.	1907				1908			
	Begun.	Finished.	Number of barrels.	Net pounds.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 12	May 10	22⅛	9,498.5	Apr. 20	Apr. 24	16¼	6,956.0
2	May 22	June 15	20¼	8,775.0	May 29	June 9	15	5,949.0
3	July 9	July 23	22¼	9,735.0	Aug. 1	Aug. 3	17¾	7,605.0
4	Aug. 23	Sept. 12	19⅞	8,744.0	Sept. 1	Sept. 5	21¾	9,457.0
5	Oct. 13	Nov. 28	34½	13,781.0	Nov. 16	Nov. 17	13	5,666.0
Total			119	50,533.5			83¾	35,633.0

1907. Number of chippings, 30. Scrape, 9,742 pounds.
1908. Number of chippings, 27. Scrape, 13,772 pounds.

Crop C dippings.

No.	1905				1906			
	Begun.	Finished.	Number of barrels.	Net pounds.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 29	May 15	17⅜	7,418.5	Apr. 5	Apr. 19	22⅛	9,287.5
2	May 29	June 15	23⅜	9,932.0	May 8	June 4	29	12,218.5
3	June 28	July 20	24½	10,304.5	June 19	July 13	28½	12,170.5
4	July 29	Aug. 25	23¾	10,068.0	July 30	Sept. 4	28	12,187.5
5	Sept. 12	Sept. 22	26	11,019.5	Sept. 17	Oct. 16	21⅜	9,228.0
6	Oct. 11	Nov. 16	24½	10,520.5	Nov. 9	Nov. 14	18⅝	8,080.0
7	Nov. 22	Nov. 27	7¾	3,324.0				
Total			147¼	62,587.0			147⅝	63,172.0

1905. Number of chippings, 31. Scrape, 7,245 pounds.
1906. Number of chippings, 35. Scrape, 10,410.5 pounds.

No.	1907				1908			
	Begun.	Finished.	Number of barrels.	Net pounds.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 19	Apr. 26	22½	9,685.5	Apr. 13	Apr. 17	17⅛	6,680.0
2	May 27	June 7	20	8,660.0	May 25	May 29	17⅝	7,622.0
3	July 8	July 29	24½	11,320.0	July 26	Aug. 3	17¼	7,881.0
4	Sept. 3	Sept. 13	23¾	10,289.0	Sept. 10	Sept. 12	20	8,650.0
5	Nov. 4	Dec. 12	23¼	10,920.0	Nov. 22	Nov. 22	16	7,028.0
Total			114	50,874.5			88	37,861.0

1907. Number of chippings, 30. Scrape, 8,207 pounds.
1908. Number of chippings, 28. Scrape, 13,240 pounds.

Crop D dippings.

No.	1905				1906			
	Begun.	Finished.	Number of barrels.	Net pounds.	Begun.	Finished.	Number of barrels.	Net pounds.
1	May 3	May 19	22⅝	9,644.0	Apr. 5	Apr. 20	31⅞	13,265.0
2	May 31	June 20	28	11,866.5	May 11	June 8	37⅞	15,922.0
3	July 1	July 22	28½	11,941.5	June 22	July 19	28⅝	16,487.5
4	Aug. 3	Aug. 26	28⅜	12,004.5	Aug. 2	Sept. 7	25¼	15,477.0
5	Sept. 13	Sept. 29	29⅜	12,908.0	Sept. 21	Oct. 18	27⅛	11,902.0
6	Oct. 12	Nov. 15	28⅝	12,286.0	Nov. 16	Nov. 24	20⅜	8,618.5
7	Nov. 22	Nov. 23	7½	3,053.0				
Total			173⅛	73,703.5			190⅝	81,672.0

1905. Number of chippings, 31. Scrape, 8,888 pounds.
1906. Number of chippings, 34. Scrape, 13,764.5 pounds.

No.	1907				1908			
	Begun.	Finished.	Number of barrels.	Net pounds.	Begun.	Finished.	Number of barrels.	Net pounds.
1	Apr. 18	May 1	24⅞	10,726.0	Apr. 13	Apr. 17	19¾	8,608.0
2	May 31	June 5	18⅝	8,110.5	May 18	May 19	23	9,967.0
3	July 17	July 29	31	13,796.0	July 20	July 27	32½	14,125.0
4	Aug. 26	Sept. 18	28	12,068.0	Sept. 18	Sept. 21	20	8,648.0
5	Oct. 9	Nov. 20	39¾	17,418.0	Nov. 22	Nov. 23	17	7,368.0
Total			142½	62,118.5			112	48,716.0

1907. Number of chippings, 26. Scrape, 11,006 pounds.
1908. Number of chippings, 28. Scrape, 17,342 pounds.

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